The Genesis of Heavy Haul Freight Railroads in the Pilbara

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In 1957 the Japanese Government introduced a programme to double the per capita income of Japanese citizens between 1960 and 1970. One feature of the n plan was to double steel production, and to increase pig iron production by 280 per cent. This opened up an opportunity for mineral rich Australia to create a new export market and to be a partner in the plan. For this to occur it was vital for new infrastructure to be constructed, and as a result, many railways were built in Australia in the 1960s in response to demand created by the industrialisation of Japan.[1] This article will briefly examine the different approaches to operating the new freight railways by the state governments of Queensland and Western Australia but will focus mainly on developments in the latter state.

State Railways

The two states with large reserves of coal and iron ore were Queensland and Western Australia. Both had state owned narrow gauge, 3ft 6 in., railways. When railways were first built in Australia there was a shortage of capital and colonial governments by necessity became involved in their ownership. Sadly because politicians rarely understood the operation of railways few proved economically viable. When the colonies became states they retained ownership of the railways, but for many years this ownership proved a disaster both for the railways and for the national economy.[2]

Both Queensland and Western Australia realized that new railways had to be built to exploit their coal and iron ore deposits, and that the Commonwealth would not support a bid for a special loan from the Australian Loan Council to achieve these objectives. Thus, they had to be inventive in finding finance for the new lines. The answer by the Queensland Government was for the coal mining companies to pay for the construction of the new state–owned, narrow gauge (3ft 6 in.) coal haulage railways. To fund them, the Government used a financial device, a refundable security deposit. The deposit provided by the mining companies to the Government to pay for the railway construction was later repaid by the government to the mining company from freight rate revenue. When additional costs ensued, the Government increased freight rates to cover them. Fortunately, coal proved a valuable commodity and was able to bear the cost. The rate charged was based on what the traffic would bear and eventually the surplus achieved was used to subsidise Queensland Rail, allowing them to run inefficient and uneconomic services.[3] Another problem was that the export coal railway system was not integrated, as there were separate owners of mines, railways and ports. This separation was a source of day-to-day conflict between all parties and made it difficult for long term planning to take place.[4]

Another problem for Queensland was that it was difficult to use high axle loads on the narrow 3ft 6 in. gauge track to enable the carriage of heavy loads. The normal axle load was 12 tons and with upgraded track could be increased to 17.7 tons.[5] However, on standard gauge [4ft 8½ inch] the normal axle load was 23.5 tons and that could be increased to 30 tons.

Western Australia decided on a different approach. Iron ore was not a valuable mineral and a high freight rate for transport would have proved prohibitive for development. It was with this in view that the Western Australian Government decided that any new iron ore railways would be built to standard gauge by the mining companies, and also operated by the people who used them, so as to make an integrated transport system. This was the environment that created the Pilbara Australian heavy haul freight railroads.

Private Railways.

In 1960 there were no major private railways in Western Australia.[6] Just 12 years later there were four in the Pilbara – one private railway, and three private railroads.[7] Although largely unknown to the Australian general public, they were for many years unique amongst the world's freight railways and remain highly regarded by railway professionals for their many advanced technical and operating innovations.

Despite claims by mid-twentieth prospectors that they were responsible for discovering iron-ore deposits, the Western Australian Colonial Government was aware in the nineteenth century of the vast iron ore reserves in the Pilbara, but the difficulty and cost of transporting the ore to the coast made mining unviable. In 1889 Government Geologist Harry Page Woodward reported that 'This is essentially an iron country ... There is enough to supply the whole world, should the present sources be worked out'.[8] He argued that because of insufficient local capital, it was necessary to seek overseas assistance to finance development of the material.[9]

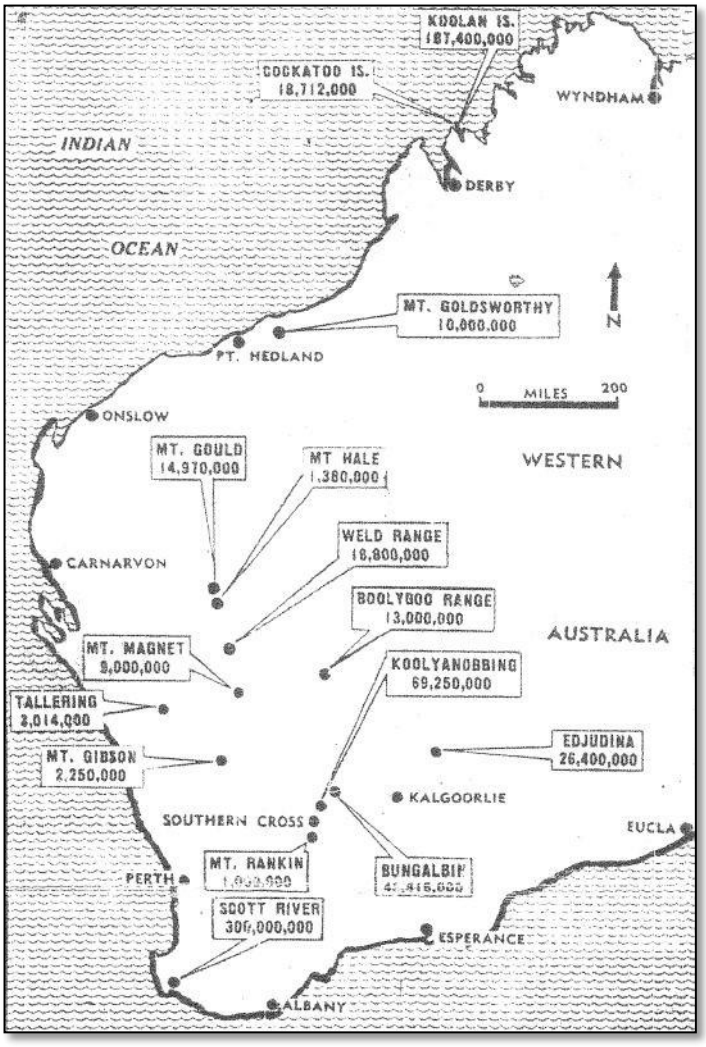
In 1919, it was authoritatively claimed[10] that iron ores were widely distributed throughout the state, but initially it was the major high-grade deposits of Koolan and Cockatoo Islands that received most attention. H.A. Brassert &
Company of London took up the iron ore leases on Koolan Island in 1936.[11] Registered in Western Australia, it appeared to be a local company but was a front for the Nippon Mining Company. The Commonwealth Government, however, wary of assisting Japan in its war with China, emphasised its neutrality by declaring an embargo on the export of iron ore to all countries, claiming there were insufficient reserves in Australia.[12]

David Brand became the Western Australian Liberal Party leader in 1957 and he had Charles Court prepare an aggressive policy for the 1959 election. Court and Brand worked on plans to develop the economy, increase employment, and expand population. When Brand took office he appointed Court as Minister for Industrial Development of the North West, and Minister for Railways. Court assembled a team to work on new development policies based on promoting the state's iron ore industry. Reluctant to raise the export embargo, the Commonwealth Government opposed infrastructural developments that they considered too ambitious and costly.

Expecting this response, Court and Brand planned for alternative finance by declaring any new railways and ports in the north would have to be built by private enterprise, and in the case of railways, operated by them.[13]

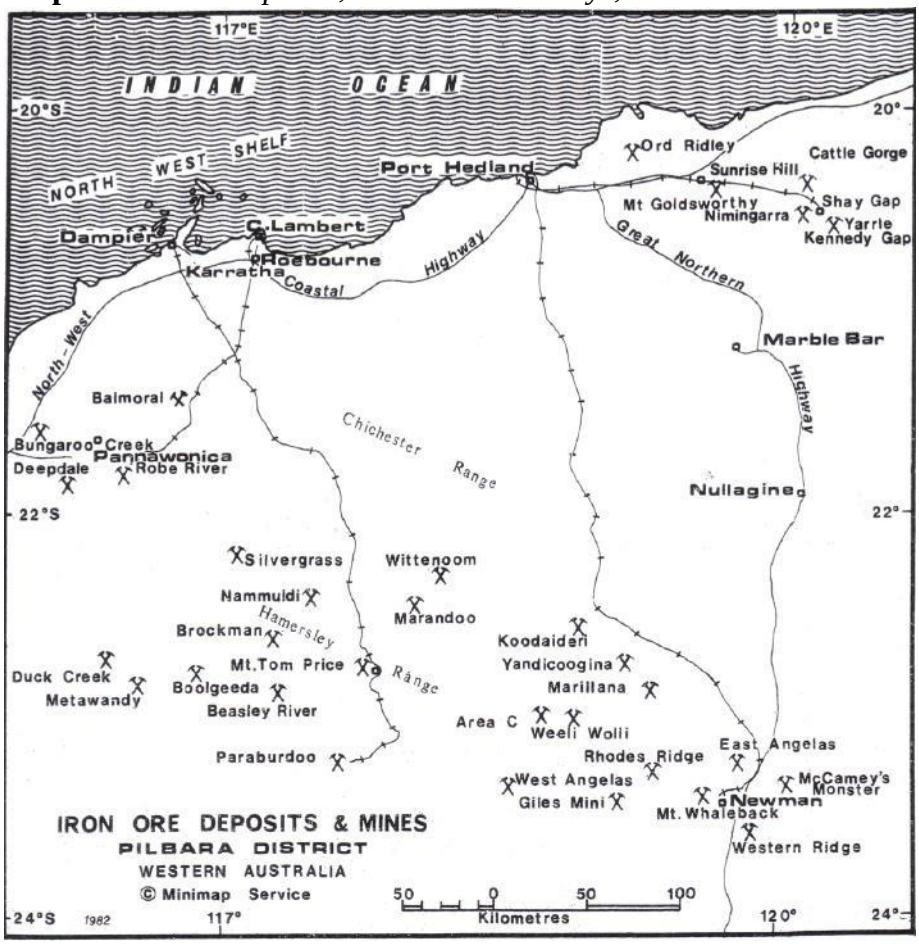
In its plans for the development of iron ore, the new Government, hoping to value-add, wanted a Western Australian integrated steel works as part of any deal with mining companies, and used this in its negotiations with Broken Hill Proprietary (BHP), which wished to exploit the iron ore at Koolyanobbing. With a view to the Company constructing a blast furnace and steel works at Kwinana, a few kilometres from Perth, Court used the resulting negotiations and agreement to create a Western Australian Government Railway standard gauge railway to connect to both the port at Kwinana and with the transcontinental standard gauge.[14] The standard gauge was particularly valuable to the iron ore industry, as it was capable of shifting larger and thus more economic loads than the narrow gauge alternative. Following successful negotiations with the Commonwealth Government to share the costs of the project, the Brand government in August 1961 announced the go-ahead for construction of 800km of standard gauge railway,[15] and fought to remove the export embargo on iron-ore.:

Map 1: *Known WA Iron-ore reserves 1960.*



Source: *The West Australian*, 3 December 1960.

Map 2: *Iron Ore deposits, Mines and Railways, Pilbara. Circa 1980.*



Source: Minimap Service.

On 21st March 1960, the Federal government considered lifting the iron ore embargo but a final decision was held in abeyance until the views of the Australian iron and steel industry were received. BHP pointed out that they were importing iron ore from New Caledonia, which met their requirements, and were thus not enthusiastic about having additional reserves. However, after being asked to clarify their statement, BHP agreed that the lifting of the embargo could encourage more prospecting leading to a greater spread of reserves. [16]

On the 13 May 1960, the Premier of Western Australia made representations to the Prime Minister for an early relaxation of the embargo.[17] Then on 7 November, Mineral Mining and Exports (W. A.) Pty. Ltd., a company owned by Heine Brothers and the Griffin Coal Mining Company Ltd., formally asked permission from the Federal Government to export 500 tons of limonite iron ore from the Scott River deposit in the south of Western Australia. On 24 November, the Commonwealth agreed and acceded to Western Australia's request to review the prohibition in regard to this request.[18] The relaxation, reported *The West Australian*, was to allow iron ore exports on 'a carefully controlled and limited basis',[19] and to stimulate the discovery of new deposits.

With the field now open to development, Court set about streamlining government by employing small numbers of competent people to make, manage and guide transparent decisions through the many bureaucratic mazes. His major innovation in this area was a 'one-stop-shop' for resource developers, the Department of Resource Development (DRD).[20] His second innovation was to use agreement Acts of the State Parliament to effect contracts between the resource companies and the State Government.[21]

Financing the infrastructure for rapid growth in a relatively short space of time was beyond the means of the state government, forcing it to adopt a course that relied on individual companies, or conglomerates, to provide all facets of development. This saw Court devise a system whereby, for the privilege of being granted iron-ore concessions, companies had to provide everything, including the cost of local government facilities, local transport, housing, hospitals, power and water supplies. The agreement acts have been described as 'franchise agreements': although usually seen as dominated by obligations the companies had to meet, they also placed obligations on the State Government.[22] These requirements led to a novel technique of financing, using the agreement Acts and sales contracts to borrow funds.[23] Effectively, the lenders advanced funds, not on the financial capability of the promoters to repay, but on the viability of the project. This approach was sometimes called 'project financing'.[24] One parliamentarian concluded that such agreements saw 'Venturers take all the pecuniary risk, … [while] the State is practically free of any financial obligation whatever'.[25]

When in early 1961 the Western Australian Government was preparing an invitation to tender for the Mt. Goldsworthy deposit, Consolidated Gold Fields (Australia) Pty Limited suggested to Cyprus Mines Corporation that they submit a joint tender. Cyprus Mines in turn successfully proposed that Utah Australian Ltd be invited to join them, but on 4 September 1961 the Goldsworthy Joint Venturers submitted a tender that was successful.[26]

In the invitation to tender, the nominated port for the export of the Mt. Goldsworthy ore was Port Hedland. However, Utah Development, in the investigation preceding the tender, considered three ports. The first, Cape Keraudren, was only a short distance from Mt. Goldsworthy but clearly unsuitable as a main port and considered only as a trans-shipment port. The second was Port Hedland but London consulting engineers Rendell Palmer and Triton argued, that if more than a million tons of ore were shipped from there, expensive dredging would be needed. The joint Venturers then decided to carry out a feasibility study of the third port option, Depuch Island. This involved building a 125-mile (201km) railway to the mine, a substantial causeway to link the island to the mainland, a port, and a new town. Initially only a preliminary agreement, this option had to be passed by Parliament. However, the move was not without objection, and Labor leader in the Legislative Council, Frank Wise, questioned the need for the Bill by focusing on the schedule for the construction of the railway, claiming it was in conflict with the requirements and demands of Section 96 of the Public Works Act, 1902. Griffith reluctantly agreed to a second Bill that would

conform to the Public works Act and eventually the Mount Goldsworthy – Ord Ranges – Depuch Island Railway Agreement Act, 1962 was assented on 20 November 1962.

Part 5 of the 1962 Agreement required the Joint Venturers to ship 15 million tons of iron ore at a rate not less than one million tons per annum. They were to construct

> in accordance with the recognised standards of railways of a similar nature operating under similar conditions … a 4 feet 8 ½ inch gauge railway (with all necessary signalling switch and other gear and all proper and usual works) from the mining area to the mainland end of the causeway.

and to provide sufficient locomotives, freight cars and other railway stock to haul the specified tonnage of ore. Although also required to 'transport passengers and carry freight of third parties', 'providing this did not interfere with their operation', the Joint Venturers were not to be deemed 'common carriers at common law…'. [27] This last, unusual requirement was clearly inserted by Court, who understood the damage that had been done to other railways by the requirements of the 'common carrier' obligation.[28]

The first railway

Goldsworthy Joint Venture's (GJV) main objective was to build a railway at the lowest possible cost. They used a set of Australian railway standards for their design and economic calculations, and then by iteration re-examined them as they worked up their designs. They used the Australian standard rail gauge of 4 ft. 8½ inches; an axle load of 23½ long tons; and flat bottom rails of 107 lbs per yard in 45 ft. lengths fastened with dog spikes through tie plates, on Australian hardwood sleepers at 2,640 per mile. The average cost for construction using these standards across open country on the Depuch Island line was £29,000 per mile. Using gravel instead of crushed rock as ballast the cost could be reduced to £24,000 per mile.[29]

They then considered reducing the axle load from 23½ to 18 long tons, enabling a lighter rail such as 82 lbs. per yard to be used, and reducing the number of sleepers from 2,640 to 2,400 per mile. This gave a cost of £18,000 per mile or 38 per cent less than the initial proposal. The engineers calculated that replacing the standard 4ft. 8½ inches to the Western Australian Railway narrow gauge of 3ft 6 inches would further reduce construction by £1,000 per mile. But they did not recommend this change, being aware that Charles Court was adamant any new railways should be built to standard gauge.

When GVJ finally decided to use Port Hedland as its terminus port, the final design and construction of the railway began. While at the outset mining project owners will inevitably concentrate on railway construction costs in the life of a project, running costs are more important, and will normally be based on the shortest possible distance between mine and port. The decision to go to Port Hedland, 70 miles from Mt.

Goldsworthy, rather than the 125 miles to Depuch Island, significantly reduced running costs in fuel consumption, maintenance of rolling stock and track, and railway manning. In October 1965, the Goldsworthy Joint Venture became Goldsworthy Mining Pty. Limited (GML).[30]

The line was built between Finucane Island, Port Hedland, and Goldsworthy as a single-track railway with a generally flat track profile with a maximum or ruling grade against the loaded train of 0.33 per cent, and 0.66 per cent against the empty train with, initially, a passing loop at 12 miles from Finucane Island, and a dead-end passing siding at 44 miles. It was decided to use a bottom dump unloading system, the only one in the Pilbara.[31]

As the first private railway in the Pilbara, GML was concerned about the supply and maintenance of the rolling stock. The locomotive manufacturer, English Electric Co. of Australia Pty Ltd was in Rockley, Queensland, and the wagons were from Tomlinson Steel in Perth, WA and Scotts of Ipswich Pty Ltd, Queensland. GML aligned with the West Australian Government Railways [WAGR] with its extensive workshop facilities in Perth. The railway was a clone of the new WAGR standard gauge railways being built at this time. A very close relationship with WAGR included exchange of locomotives and may have reflected WAGR's hope it might take over the railway and its rolling stock when the mine was finally closed.

In 1966 WAGR placed orders for nine of the new 108 ton English Electric locomotive from Queensland, the K-class. GML joined WAGR and ordered three larger English Electric diesel electric locomotives. They arrived between October 1966 and March 1967 with a 1795 HP (1339 kW) engine on a Co-Co[32] arrangement, with an axle weight of 18 ton, and became designated as their GML 3, GML 4 and GML 5 locomotives. [33]

Damaged by Cyclone *Shirley* in April 1966, just one of the hazards faced over the years [see Figs 1 & 1A], the track was not completed until 19 May 1966. The first ore train ran with 21 loaded ore cars, hauled by locomotive GML 2, to Finucane Island on 25 May. On 3 June 1966, the 30,000-ton iron-ore carrier *Harvey S. Mudd*, carrying 25,000 tons of High-grade hematite, became the first ship to sail for Kawasaki in Japan. *34*

Heavy haul railroads

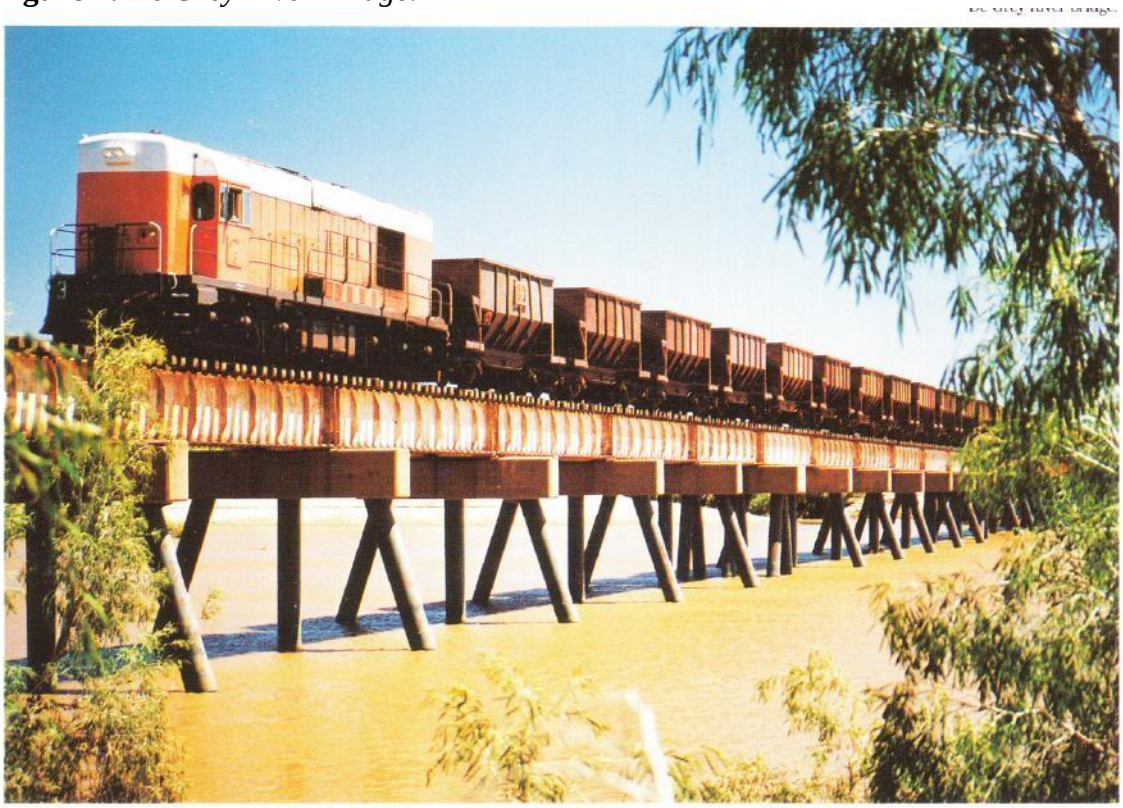
Hamersley Iron

GML chose to build a normal Australian railway because their mine was small, with a limited life. The next three Pilbara mines, Hamersley Iron (HI), Mount Newman Mining (MNM) and CRRIA (Robe River), were larger and predicted to have longer lives.

The Rio Tinto Company Limited, registered in London, formed a subsidiary in Australia in 1954 to mine uranium. In 1959 it changed the subsidiary's name to Rio Tinto Holdings (Australia) Pty Ltd and created the Rio Tinto Mining Company of Australia Limited, which became a public company in 1961. In 1962 another British-

controlled company in Australia, the Consolidated Zinc Corporation Limited (CZC), concerned about the falling price of zinc, merged with Rio Tinto: the Rio Tinto – Zinc Corporation Limited and their Australian interests became Conzinc
Riotinto of Australia Limited (CRA).[35]

Figure 1: *De Grey River Bridge.*



Source: William Walker Collection.

Figure 1A: *De Grey River Bridge during flood, April 1996.*

Source: William Walker Collection.

Pastoral Station owner Lang Hancock, and prospector E.A. Wright, after discussing their iron ore discoveries with Rio Tinto, signed a formal agreement with them on 11 September 1959. Although interested in opening a new mine, Rio Tinto hesitated, as it was concerned about transportation costs to the coast:

> It was by no means clear that it would be permissible to own and operate a private railway, and in any case the known costs of rail transport elsewhere in Australia at that time were horrific. Sixpence a ton/mile or more from Broken Hill to Port Pirie, and about the same or worse from Mount Isa to Townsville…[was] rather more than Bell Brothers were charging for road transport in the Pilbara at the time. [36]

A study for Rio Tinto by Pat Hannaberry, former Commissioner of the Commonwealth Railways, concluded that iron ore could be carried for about 2 pence a ton–mile.[37] Other studies showed it could be mined for about 10 shillings a ton and was worth £5 a ton on board a deep-water vessel. Therefore, according to Hannaberry's calculation, the transport cost for a mine 100 miles from the coast was about 17 shillings a ton. If one of the state railways carried the ore at 6 pence a tonmile, the transport cost would be £2 10 shillings a ton.[38] On the basis of these studies, the company told the Western Australian Government it was interested in mining iron ore in Australia and operating its own railway.

Because CRA had difficulty convincing the Western Australian Government of its capability, Maurice Mawby, Chairman of CRA, used a Consolidated Zinc

connection to invite Kaiser Steel to participate in the project. During the Second World War the United States mobilised all its industrial strength and Henry J. Kaiser, a West Coast shipbuilder, responded by applying motorcar mass production techniques to ship building. He motivated his workforce with high pay and fringe benefits. Justifying his reputation for 'getting things done fast',[39] Kaiser reduced the time to build a freight ship from 300 to 17 days. Interested in the iron ore project, he sent Tom Price, one of their most important executives, to study the proposal and to meet the Government. Six months after being awarded all the temporary reserves they applied for, Mount Tom Price was discovered and named in honour of the Kaiser executive.

Hamersley Iron Pty. Limited was created in October 1962 with CRA holding 60 per cent and Kaiser 40 per cent of the stock. The nine directors included four Americans, four Australians and one Englishman, Val Duncan, a Rio Tinto representative. Maurice Mawby, an Australian, headed the management.[40]

Following an agreement on 30 July 1963 between Hamersley Iron and the Western Australian Government, the Iron Ore (Hamersley Range) Agreement Act No. 24 was finalised on 13 November 1963. It described the obligation of the company to construct a railway along an agreed route, with a rail gauge of 4ft 8½ins, hauling at least one million tons of iron ore per annum. In clause 10, (2), (a), the railway was **not** deemed to be a 'common carrier at common law or otherwise'.[41]

In December 1964, CRA decided to use its own subsidiary, Central Engineering Services Pty Ltd (CES) to construct the railway.[42] Design work began after the port site at King Bay was confirmed. Dick Barber, a Kaiser executive with a railway family background, suggested the railway be constructed to American standards. Railroads in the United States at this time were moving to longer and heavier unit coal trains. The track standards compiled by the American Railway Engineering Association (AREA) and the rolling stock standards by the Association of American Railroads (AAR) were used in the Hamersley Railroad design. The original design criteria were set for haulage of 8 million gross tons per year to 16 million gross tons per year with a 30-ton to axle load.[43] The route from King Bay to the mine at Tom Price was matched to the required train performance.[44]

Kaiser and CRA determined the new railroad would operate unit trains. A manual, written later by Kaiser's James R. Barber and Roger D. Brackett, describes their operation:

> A unit railroad train consists of a dedicated set of haulage equipment, loaded at one origin, unloaded at one destination each trip, and moving in both directions on a predetermined schedule over a fixed route. When operating in one direction, all the cars in the train are normally fully loaded and in the other direction empty.[45]

A major aim of the railroad engineer is to ensure that the locomotive loads are 'equal' in each direction. This can be accomplished on a mining railroad because the

empty train normally runs uphill to the mine and the loaded train down to the port at sea level. To achieve a balance is ideal but difficult, necessitating compromises on the gradient of the track. The maximum gradient that determines the size of the load is called the Ruling Grade. The maximum grade in the empty direction must not affect the ruling grade. The track from Dampier to Tom Price is balanced, the ruling grade against the loaded train is 0.33 per cent, and against the empty train 2 per cent.

The contractors employed to build the railway were a joint venture group, MKMM: American company Morrison-Knudsen International; Mannix Co. Ltd. of Canada; and McDonald Constructions Pty. Ltd. of Sydney. They were awarded a $US16 million contract in April 1965, and work began under their direction on 16 June.[46] Although it had been planned long before Hamersley Iron, GML did not begin work on their railway until October 1965. [47]

One reason for the delay was that Hamersley wanted to use long strings of rail manufactured in Japan, which could not be supplied by BHP.[48] Senior WAGR officials, visiting the rail works, questioned the proposed construction schedule. They did not believe the aim of laying a mile (1.6km) of track a day could be achieved, raising doubts in the mind of the State Government.[49] It was estimated that, including yards and sidings, 400 kilometres of track would have to be laid.

The rapid construction pace was important as Hamersley had, in competition with Mount Newman Mining (MNM), submitted a tender in 1964 to supply 65.5 million tons of direct-shipping ore over 16 years to the Japanese steel mills, beginning in 1967. Concerned that their tender would not be accepted and wanting to impress the Japanese, they reviewed their construction schedule. After determining a reduction from 36 to 27 months construction time was feasible, the CES engineers were asked to reduce it further. Given some latitude on costs, they concluded they could reduce it to 16 months, and informed the Japanese they could ship ore in 19 months from the start of construction. On the strength of this undertaking they were awarded a contract on the 18 December 1964 to supply 65.5 million tons of iron ore, at an initial rate of 4.5 million tons per year, beginning in August 1966.[50] The estimated total cost of the project was $88 million: its final cost of $105 million made it the largest investment in a new mine in Australia at that time.

One of the first principles of railway/railroad operation is to keep traffic moving.[51] Once a train is emptied it should start its journey to the mine, be immediately loaded on arrival, leave the mine when loading is completed, and be unloaded immediately on arrival at the port. If there is insufficient ore at the mine or, more likely, if a train cannot be unloaded because port stockpiles are full, it becomes a mobile stockpile held in a siding until it can be processed.

Kaiser used experience from their iron ore mine at Eagle Mountain in the United States to assist with the Hamersley mine planning.[52] The plan allowed for primary, secondary and tertiary crushing of ore at the mine, in effect moving a bottleneck from the port to the mine and ensuring the wagons (ore cars) when loaded would keep moving. If the ore is crushed and graded at the mine, size and grade are known, and homogeneous stockpiles can be created before it is loaded and so can be

immediately unloaded at the port. If tertiary crushing and final grading is done after the train journey, the ore in the train may not be suitable to mix with the existing stockpiles; it may have to wait for Quality Control to decide when it can be unloaded.

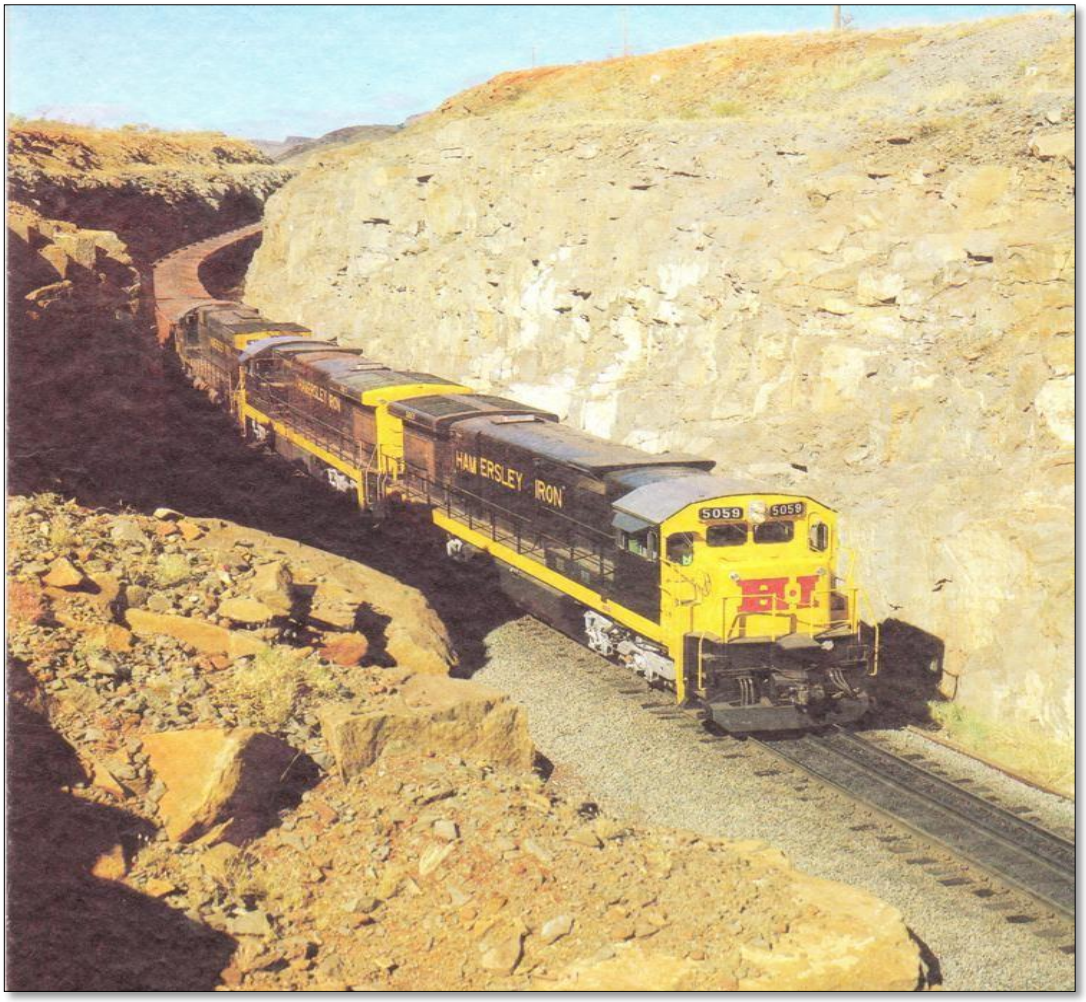
Other excellent decisions by the CES planners were to build a state of the art railroad with the largest rail available, purchasing the largest locomotives and lightest cars. The line when completed was 288km of single track from 762m above sea level at Tom Price to sea level at Dampier, with 12 passing sidings, approximately 20km apart.

An iron ore train is made up of ore cars (wagons) linked with automatic couplings and hauled by a locomotive. The selection of motive power is a vital decision, for locomotives are very expensive to purchase and maintain, can have high running costs and need to be chosen for reliability. Locomotive life is measured in decades, normally between 20 and 50 years and[53] a decision to purchase once made, cannot easily be changed

In 1963 the market shares of the three United States locomotive manufacturers were General Motors Electro Motive Division 80 per cent, Alco[54] 10 per cent and General Electric 10 per cent[55]. Yet, HI, MNM and Robe River chose to purchase Alco locomotives. The first reason was that one large locomotive cost less and was cheaper to run than two half its size: Alco had the largest locomotives. Second, Alco locomotives had a good reputation in Australia. However, the companies either ignored or were unaware of many reasons against purchasing Alco locomotives when making their selection.

A.E. Goodwin, the Australian Alco locomotive manufacturer in Auburn, NSW, seemed the ideal supplier. Yet by October 1969 Alco announced that it was going out of the locomotive manufacturing business, as its percentage share of the United States locomotive market was zero. There was room for only two manufacturers, GM (EMD) and GE. The Alco business was transferred to the Montreal Locomotive Works in Canada, which continued to supply locomotives to Canadian railroads and components to Goodwin. Initial problems at Hamersley Iron became worse because the Pilbara iron ore locomotive rating had been pushed to an unsustainable level.

Figure 2: *Hamersley Iron 23,000 tonne ore train of 180 ore cars hauled by two GE C36-7 and one ALCO M636 at 275 km near Tom Price c.1880.*



Source: William Walker Collection.

Ore cars appear of relatively simple construction, a steel box on two simple bogies, and apparently unlikely to cause major problems, what was not foreseen by the mining companies was that the cars were purchased in large groups, so one faulty component could cause, not one car, but a whole group to fail. Even worse, some components such as bearings, couplers, knuckles, draft gear, brake equipment, wheels and axles were common across the whole ore car fleet, so a major fault in these could take out large numbers of cars. Timken bearing failures were a major problem for all the railroads. The first HI ore car order, delivered in 1966-67, was for 203 cars from Nippon Sharyo in Japan, which was a copy of the Southern Pacific gondola car used to move the iron ore from Kaiser's Eagle Mountain mine.[56]

Mount Newman Mining

The MNM deposit was discovered in 1957 by A.S. 'Stan' Hilditch while searching for manganese. Samples he sent to his partner in Sydney, engineer C.H. Warman, assayed at 68.8 per cent iron. In 1961/2 the Western Australian Government granted them temporary reserve leases but lacking the resources to develop them, they looked for partners.

AMAX, an American company, formed from a merger of Climax Molybdenum and the American Metal Company, were concerned about their dependence on Molybdenum, and determined to diversify into other businesses. Ian MacGregor, an AMAX executive, moved them into Aluminium production and iron ore mining.[57] In 1963 he and another AMAX executive visited Australia to look at mining opportunities, and while there they met Warman, who told them about Mount Newman. After arranging for a team to carry out further investigations they knew by May 1964 that Mount Newman was a major iron ore deposit. Its one problem was that it was located 265-miles (425km) from the nearest port at Port Hedland, it made it a very expensive project to develop.[58]

To reduce their exposure to high development costs and economic risks Amax invited the Colonial Sugar Refining Company (CSR) to join them, with each company to hold a 50 per cent interest. In 1964, leases and plans were agreed with the Western Australian Government, and negotiations for the sale of iron ore opened with Japanese steel companies. The initial capital cost was US$160 million, but in a period of high inflation these costs were unstable. The Japanese expressed an interest in purchasing five million tonnes of iron ore per year at a price between US$9 to US$12 per tonne, but this was insufficient to build the project and provide a reasonable return on the capital. *Australian Financial Review* journalist John McIlwraith recalls meeting Ian MacGregor in 1966, the year after he was appointed president of AMAX: 'his despair clearly showed the frustration and disappointment breaking through his normally courteous and dry humorous manner'.[59]

The Western Australian Government became involved, and in March 1966, Court organised a meeting in New York between Amax, CSR and Hamersley. Subsequently, Hamersley offered to carry MNM's ore on their railroad and allow use of their port for a charge of $1 per ton to help MNM meet its initial contract of 100,000,000 tons.[60] The offer was not acceptable to MNM, but through continuing negotiations AMAX secured an agreement with eight Japanese steel companies to provide them with 100 million tonnes of ore over 22 years (5 Mt per year) from April 1969.[61]

The four-year timetable to construct a mining complex, railroad and port from drawing board to completion was daunting, as was the cost now soaring to over US$200 million. MacGregor later wrote:

> This represented $40 per cent annual tonne of iron ore capacity, a figure which looked extremely high in comparison with mines that had been built in other parts of the world in the previous decade. Thus the project was halted while the partners desperately tried to find ways to reduce the capital cost or increase their throughput. This resulted in efforts to increase the size of the consortium.[62]

The project was in trouble, the cost of the proposed railroad too expensive, and the time to complete it insufficient. The situation became even more complicated as

different groups vied to direct the Mount Newman project. Federal Trade Minister, John McEwen wanted CSR to remain a dominant partner, and in an attempt to help CSR diversify away from dependence on sugar he suggested that Mount Newman use Hamersley's railroad and port to reduce costs. Describing these manoeuvres as sugar politics, Charles Court drove the Western Australian Government's strong opposition to the proposal, arguing it would jeopardise exports because the coast where the proposed port(s) lay was subject to severe cyclones. He wanted ports far enough apart to ensure that one cyclone would not shut them all down, but was also concerned that the project did not help his goal of populating the Pilbara.[63]

In March 1966 AMAX tried to attract the American Cleveland Cliffs Iron Company (Cliffs) into the Mount Newman Mining Joint Venture Group. They succeeded for a short time by suggesting AMAX share their iron ore contracts and ore from their Robe River project. But the agreement ended in July 1967. At this juncture, AMAX seriously considered downgrading the railroad, but a retired American railroad chief engineer engaged by MacGregor to review the proposal, noted the railroad's length and isolation, and strongly recommended it be upgraded, rather than downgraded.

Further difficulties arose as the Japanese steel mills, manipulating quantities and prices in the iron ore contracts, were playing the different joint venture groups off against each other, even though they began to realise that the MNM project was a major deposit that needed to be brought into production.

There were also serious problems with raising capital for a project in crisis. A new Interest Equalization Tax on loans raised in the United States by Commercial banks, and on share investments in other countries, made it difficult for AMAX to raise funds. H.C. Coombs, Governor of the Reserve Bank, rejected a request for access to the Statutory Reserve Deposits of the trading banks to finance the MNM project.[64] However, the Japanese Government, responding to Australian requests for assistance for AMAX, successfully lobbied the United States Government to exempt the MNM project from the new tax, arguing that it 'was the most valuable of all the iron projects in Western Australia'.[65] Although AMAX could now raise their share of capital in America, they needed yet another Australian partner to assist in raising the Australian share, and turned their attention to BHP, the pre-eminent Australian company.

Initially BHP had not been in favour of exporting iron ore from Australia[66] but, as more deposits were discovered, they realized that low cost high-grade iron ore could be shipped from the Pilbara at a lower freight rate than to the east coast of Australia, thus enabling the Japanese mills to manufacture cheaper steel than they could produce in Australia. Already with good deposits in Western Australia at Yampi Sound and at Koolyanobbing, they began applying for temporary reserves, sent teams of geologists to search for iron ore and contemplated alliances with joint venture groups. After negotiations, BHP was invited to replace Cleveland Cliffs and join AMAX and CSR in the venture. In MacGregor's words, 'the entry of BHP into the Mount Newman consortium was the essential ingredient in getting the project off the ground'.[67]

The Mount Newman Joint Venture was unique amongst the new iron ore projects: it had 60 per cent Australian funding (the largest Australian ownership); Australian management; the longest privately operated Australian railroad; and the heaviest rail in Australia – 132 lbs per yard (65 kg/m). It was the largest private construction project underway anywhere in the world.[68]

In addition to providing capital, BHP agreed to take up to an additional 8 million tonnes a year for their eastern steel mills, at a discounted price, and to manage the project. These arrangements made the Mount Newman venture viable and the consortium was organised with AMAX having a 40 per cent share and CSR and BHP 30 per cent each. AMAX later reduced their share to 25 per cent with Selection Trust (UK) taking 5 per cent, Mitsui and C. Itoh (Japan) taking 7½ and 2½ per cent respectively.[69]

The most important advantages BHP brought to the agreement were financial strength, political connections, strong management structure, confidence, and an increasing emphasis on research. After a three-month study by American consultants Cresap, McCormick and Paget, the company was reorganised in 1967 into profit centres,[70] resulting in development of a strong research centre in 1969 that employed 300 scientists and technicians.[71]

When the engineering study began, the first objective of Mt Newman Mining was to find a suitable port, with Port Hedland being selected because the railroad route was the shortest and required the lowest capital outlay. Both railroad maintenance and operating costs were estimated to be lower than for the alternative routes. GML had already built their facility on Finucane, using the most suitable jetty site, and carrying out dredging of the approach channel.[72] Inevitably there was some ongoing friction between the companies, even though agreements (the Newgold Agreements) were made for shipping access to the inner port in addition to train access to the Newgold rail level crossing.

The 426km railroad was designed by American consulting engineers Tippett Abbots-MacCarthy, with Bechtel Pacific Corporation Ltd engaged as administrator of the construction programme. Within three months they appointed MorrisonKnudsen Mannix-Oman's joint venture (MKMO) to construct the railroad. The MKM part of the joint venture with McDonald had just finished building the Hamersley railroad. With McDonald replaced by Oman for the new contract it was easy for most participants to mobilize quickly.

After tenders were received in May 1967, the construction contracts were awarded to MKMO on the 29 June, with a target completion date of March 1969. MKMO commenced railroad construction on 1 September with the establishment of a base camp and seven other camps along the length of the proposed route, while materials for the contract were to be supplied by the MNM joint Venture.

The railroad route runs north from the mine at Newman to Port Hedland, in semi-arid country, almost on the Tropic of Capricorn. The sparsely inhabited land, with summer daytime temperatures over 40 degrees centigrade, is either in drought with empty river beds or inundated by downpours of torrential rain, often accompanied by

strong winds, especially during cyclones. It is dangerous country where a number of people have died from heat exhaustion. The heat and hard work probably explain consumption estimated at 240 gallons of beer for every kilometre of track laid.[73]

Figure 3: *Mount Newman Mining locomotives with the W.A. Black Swan and Haematite symbol for iron ore. The two locomotives on the left are M636 Alco locomotives, and the one on the right a rebuilt General Electric Dash 7.*

Source: William Walker Collection.

MKMO used experienced workers from the earlier railroad constructions at Hamersley and GML. While Thursday Islanders were the backbone of the track laying gangs, people from places as diverse as Labrador and Thailand filled other positions, while among them even an Inuit.[74] Construction personnel flew to airstrips built at all the line camps and even after construction finished, a daily air service followed the railroad. An unsealed road was also constructed parallel to the rail track, and road/rail vehicles (hi-rails) were used to move people along the railroad. The normal working week for waged employees was 60 hours, plus additional overtime. Staff worked longer hours. When shift work was needed, the workforce worked day and night shifts. Sometimes four waged employees shared two-bed room accommodation in a 'hot bed' system. There were no strikes and few complaints during the construction period.

From South West timber suppliers, MNM ordered 870,000 of Western Australia's Jarrah and Wandoo hardwood sleepers. From BHP came 60,960 tonnes of the heaviest rail used in Australia. Delivered in 45-foot lengths to Port Hedland, it was welded into 1,440-foot strings. Laying of welded rail began in March 1968 at a rate of 1½ miles a day, accelerating to two miles per day until, on 8 May, a world record 4.36

miles of track was laid in 11 hours, 40 minutes. Half the track was completed by 28 August, and all track completed by 31 December, three months ahead of schedule. The first train, 40 ore cars hauled by one Alco C-636, was loaded on 18 January and the final spike was officially driven in on the 22 January 1969.[75]

Using gravity, ore was loaded into the ore cars at the mine, in a load out tunnel. The tunnel made of reinforced concrete with railway track running through it had 13 chutes that were lowered to gravity feed ore from the surge stockpile into 13 stationary ore cars. The cars were unloaded at the port using a rotary dumper. The original two-car dumper with 170 ore cars was purchased second-hand by MKMO for MNM from the Oroville Dam contractors in the United States; 144 cars were used to carry ore and the remainder converted into service vehicles, or cannibalised for spare parts. The cars were built by Magor in the United States in 1963 for the contractor and were a different size from the Hamersley ore cars. MNM ordered the same Alco locomotives as used by Hamersley, and these were built in Australia under the Alco Goodwin licence arrangement.

The first scheduled ore train of 90 cars hauled by two Alco locomotives Nos. 5452 and 5456 ran on 17 March 1969, and the first export shipment left Port Hedland on the *Osumi Maru* on 1 April. The official opening on 26 June 1969 was carried out in New York, London, Tokyo, Sydney and Melbourne, and at Newman and Port Hedland. The largest of the new iron ore mines, the construction had involved 49 principal contractors and 163 contractors on the railroad construction.[76]

Robe River

The original development at Robe River was based on 321 million tonnes of pisolite limonitic ore with average 56.5 Fe in mesas along 30 km of the Robe River that included access to BHP reserves. After pelletising, the ore improved to a blast furnace feed of 63 Fe. In 1975 BHP exercised an option in the agreement to acquire a half interest in the railroad and the port. The project continued to be managed by Cliffs Western Australian Mining (CWAM),[77] with occasional BHP inspections to ensure the railroad and port were being maintained.

Long-term contracts were signed with the Japanese steel Mills in 1969 for 87.7 million tonnes of pellets over 21 years and 73.2 million tonnes of sinter feed over 15 years. In October 1970, Bechtel Pacific Corporation USA was appointed manager of the rail project, and Morrison-Knudsen-Mannix-Oman (MKMO) awarded the construction contract. Work began soon after the MNM railroad was completed and much of the equipment and people from the HI and MNM railroads were used. In particular, the Thursday Islanders, who had begun working as a railway construction team on the upgrade of the Mt Isa railway in the early 1960s, continued together on rail construction projects from Queensland to the WAGR standard rail upgrade, to Goldsworthy and the three Pilbara railroads. CRRIA had the benefit of the experience of these legendary workers laying track at a rate of a mile a day.[78] After these major rail construction projects finished, many Thursday Islanders remained in the Pilbara employed in the track maintenance gangs at MNM and Robe River.

The 168km railroad was quickly completed, and officially opened on 8 August and handed over by MKMO to Robe River on 15 August 1972.[79] The mining sites were itinerant and had no crushing plant. The ore was mined and reduced in a primary and secondary rotary crusher to go through the train loading plant. This resulted in rocks up to 1.5 metres across being-dropped into ore cars and transported to the port to be crushed before going to the pellet plant or ship loading. The ores on the trains were immediately unloaded in a rotary dumper on arrival at the port. When the ore ran out, the loading plant was moved to the next mesa, a simple and cost effective transportation system

When it opened, the railroad ran 168km from the Mesa 2402E mine site to the port at Cape Lambert. The ruling grade against the loaded train was 0.5 per cent and 1.3 per cent against the empty train. The railroad was similar to HI and MNM's railroads, with the track designed to carry 31 tonne axle loads. The rail of 67.5 kg/m was rolled in Japan. There were three crossing loops at 45, 93 and 133 kilometres, which were increased in length in 1978. Trains operated with three locomotives and 135 ore cars. In 1978 the service was increased to six train trips per day. The first locomotives were two re-conditioned ex New South Wales Government Railway 40 Alco locomotives for shunting work, and at the same time five Alco M-636 Co-Cos were ordered to haul the ore trains. These were similar to locomotives operating on the HI and MNM railroads.

Conclusion

Cost control was simple, for direct cost was calculated at cost per ton, and profit was calculated in the same manner. GML's cheap, simple conservative railway quickly made the company very profitable, although this picture changed as additional mines were opened and the railway aged.

Almost from the start of operations serious problems emerged in the equipment of the three Pilbara railroads. In planning, Hamersley and MNM seriously underestimated the expansion of the yearly rail tonnages. The speed of construction also caused problems because the crushing of stone ballast was unable to keep up with track laying. Substitute ballast could not hold the track in the correct alignment and had to be quickly replaced.[80] Even though the original rail at HI 59 kg/m was the heaviest used in Australia, rail life very quickly became an issue. On a minimum radius curve at the Tom Price loading point, 55 per cent of the head of the outer rail was worn away in 22 months. Rail in curves had to be replaced after 75Mt had passed over them and even on the straight or tangent track there was excessive wear. Bridge and culvert design was based on insufficient data and anticipated one in 100 year flooding was occurring every two to three years. It was evident that major redesign was required on the track.[81] The rail size was soon increased to 68 kg/m.[82] MNM increased theirs from 65.5 kg/m[83] and Robe River from 67.5 kg/m,[84] both using a larger size based on HI's experience.

The initial decision to operate the railroads at 30-ton axle loads proved a problem not clearly identified at the outset. The suggestion by American

designers/consultants that 30-ton axle loads were commonly used on freight cars on United States railroads was far from the truth: unknown to the Pilbara railroads, some American railroads were experiencing similar problems. These difficulties were not revealed until William S. Autrey, Chief Engineer of The Atchison, Topeka and Santa Fe Railroad in the United States and President of the American Railway Engineering Association [AREA] gave a brief history of their experiences up to 1978.[85] He said 9,000 x 125 ton[86] x four axle cars were in use in American railroads, representing about half-a-per cent of the entire car fleet. To explain their problem he used an analogy, comparing the effect on the life of roller bearings to the life of a rolling car wheel on a rail when loads are increased. The life of a roller bearing, relative to its load, is well known. Its life is proportional to the reciprocal of the load cubed, so if the load is doubled, the life of the bearing is not halved, it is the reciprocal of two cubed, or one eighth of its normal life.

Autrey added that in 1967 one of the major American railroads, the Union Pacific Railway, was persuaded to operate 125-ton cars carrying soda ash. Normally this would imply a loaded weight of 125 tons with an axle weight (125 divided by four) of 31.25 tons. After proving popular with the soda ash shippers, 20 per cent of all soda ash movements were in 125-ton cars. But the rail tracks those cars ran on soon showed substantial damage compared to other rail. He described the experiences of the 126 km Black Mesa and Lake Powell Railroad,

> a very modern railroad built in 1973 to very fine standards. It is well maintained, but in spite of this the rail could not stand up to the beatings imposed on it by the operation of unit trains of 125 ton cars.[87]

The curved part of the track had to be replaced after 15 million gross tons of traffic, arousing concerns that, at that rate, all the rail, curved and tangent (straight), would have to be replaced at 35 million gross tons. On a railroad with a lower axle load the tangent rail would last for 500 to 700 million gross tons. The railroad decided to abandon the 125-ton car operation, return to lower axle loads, and to conduct research into heavier axle loads. [88]

The United States Federal Government has always strictly controlled some aspects of the privately owned railroads. In 1970 they decided to hand, through the Railroad Safety Act, jurisdiction over track quality to the Federal Railroad Administration (FRA). In 1976 the FRA and railroad industry set up a cooperative programme to carry out research on heavy axle loads and examine the subsequent wear and damage to wheels, rail and track. This programme for accelerated track testing was set up at the Facility for Accelerated Service Testing (FAST) test track at the Transportation Test Centre at Pueblo, Colorado. There they ran an 11,000-ton train on a four-and-a-half mile test loop for 16 hours per day for seven days a week, which has resulted in ongoing improvements.

Unlike the situation in the United States where the Federal Government took responsibility, the safety aspect of the Pilbara railroads was overseen by WAGR who were not interested in spending on a private railway. Thus, the iron ore companies did not request or receive any assistance from the State or Federal Governments when problems arose.

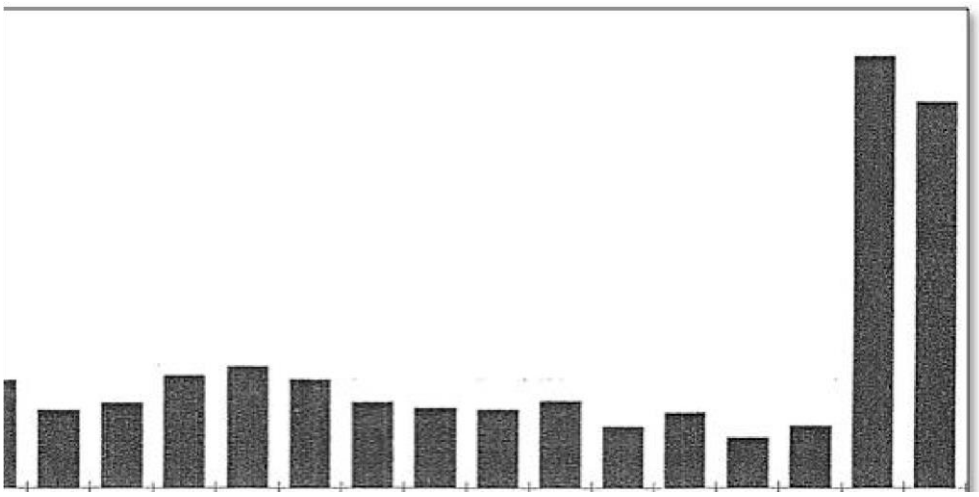
The Pilbara iron ore railroads were locked into the 30-tonne axle load because of contract obligations to the steel mills. They were operating at maximum capacity with the equipment and infrastructure to meet these contracts. HI and MNM invested a million dollars each in a research programme at BHP's Melbourne Research laboratory (MRL) to solve the problem. Beginning as a reaction to the excessive wear, the research was expanded to investigate improvements, leading to a decision to increase the axle load to 40 tonnes.[89] MNM FIRST increased it to 37 tonnes, the problem was the poor loading system, so a nominal 37 tonnes in practice was an average figure and the axle load varied between 35 and 40 tonnes. To achieve these objectives the shape of the rail was changed by grinding, and the wheel profiles also changed through using new CNC machine tools. HI started using alloy rails in curves in 1976, asymmetric rail profiles in 1979, heat-treated rail in 1980, and worn rail and wheel profiles in 1984.[90]

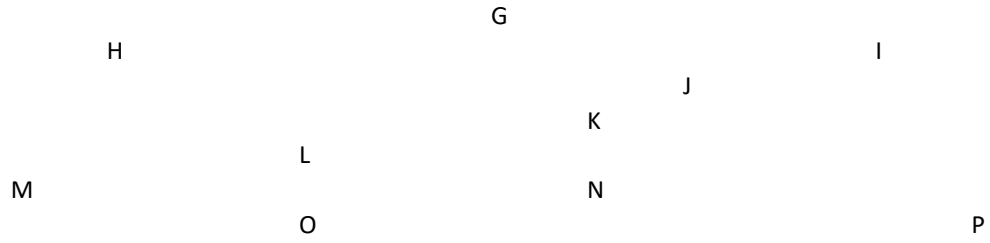
Research at a number of universities examined operating systems, locomotive design, ore car design, new infrastructure, new internal administrative procedures, new industrial relations agreements and contracts, and new accountancy and statistical controls. Information was shared with many railways and in 1978 a Heavy Haul Railways Conference was held in Perth, Western Australia. These conferences have continued and are still held in different countries.[91]

The Pilbara railways are unique for a number of reasons. One of the most important is that, unlike other Australian railways, they are vertically integrated with the mining and port infrastructures. The Australian Bureau of Agriculture and Resource Economics (ABARE), in a report in June 2006 on export infrastructure and access, commented that 'the Pilbara iron ore export chains stand out for the way that mine production, transport, cargo assembly and blending, loading and shipping are integrated'.[92] The major advantage of this is that they are very responsive to fluctuations in demand.[93] Mining companies from around the world, including the USA, Canada, Liberia, Sweden, China and Brazil have made technical visits to view the Pilbara railway operations and equipment. The largest iron ore company in the world, the Brazilian CVRD (VALE), while they were constructing a railroad through the Amazon Jungle to their new Carajas mine, sent railroad officials and engineers a number of times. Asked why they visited the Pilbara so often, they replied that they were going to build an Australian railroad in the jungle. In 1994, Travers Morgan, Planning and Management Consultants asked the Pilbara railroads to be a part of a financial/operating benchmarking exercise for an unnamed Australian railway.[94] The Pilbara railroads were benchmarked against Australian railways and U.S. Class 1 and regional railroads [Fig. 4]. The 23 U.S. railroads in the study [not all shown in Fig. 4

below] included the Union Pacific, Norfolk Southern Corporation and Burlington Northern. It was clear from the study that the Pilbara railways were world leaders in their field.

Chart 1: *NTK - Net tons per route-km (millions), 1992-1993. Various United States and Australian Railway Performances.*





Legend: **A** – SRA- Hunter Valley Coal; **B** – Denver & Rio Grande Western Railroad; **C** – Southern Pacific Rail Road; **D** – Burlington Northern Railroad; Line: **E** – Union Pacific Railroad; **F** – Atchison, Topeka & Sante Fe Railway; **G** – Chessie System & Seaboard Coast Line (CSX); **H** - Norfolk Southern Corporation; **I** - Conrail; **J** – Kansas City Southern; **K** - Chicago & North Western Railroad; **L** – Illinois Central Railroad; **M** – SCO; **N** – Grand Trunk Western; **O** – BHP (Mount Newman Mining Railroad); **P** - Hamersley Iron Railway.

Source: letter with enclosures on benchmarking, Robert Williams, Director, Travers Morgan Pty. Ltd to W. Walker, Railroad Manager, BHP Iron Ore Ltd, 17 May, in possession of the author.

Endnotes

[1] Ryóshin Minami, *The Economic Development of Japan: A Quantitative Study,* MacMillan, Hong Kong, 1994, pp. 84, 178. In this sense 'Industrialisation' is the growth of mining, manufacturing, construction and infrastructure industries such as transport. In the post – war period primary imports were metal ores, coal and petroleum.

[2] Statement by the Hon. E.G. Whitlam, in Peter Donovan, Bernard O'Neil, Christopher Jay (eds), *The Long Haul: Australian National 1978-1988,* Focus Books Pty. Limited, Double Bay, NSW, 1992, p. 7. Whitlam described the deterioration of state government railways stating that 'between 1980-81 and 1988-89 the combined losses rose from $744.1 million to $2,099.3 million and the combined subsidies from $564.1 million to $1,707.7 million'.

[3] Cameron Hazlehurst, *Gordon Chalk: a Political Life,* Darling Downs Institute Press, Toowoomba, 1987, pp. 184-186.

[4] Brian S. Fisher, Roger Rose, 'Export infrastructure and access: key issues and progress', *Australian Commodities,* vol. 13, no. 2, June quarter, 2006, p. 389.

[5] John Kerr, *Triumph of Narrow Gauge: a History of Queensland Railways.* Boolarong Press, 1998, p. 200.

[6] Stephen Brook, *The Railways of Australia,* PR Books, Singapore, 1988, p. 54. There were a number of private railways in Australia. The most successful was the Silverton Tramway Company that ran from Broken Hill to Cockburn. It was 3'6'' gauge and ran for 53 Km. Opened in 1886 it closed in 1970.

[7] Railways built to British and International Union of Railways (UIC) standards are normally called railways whereas those built to the American Railway Engineering Association (AREA) and the Association of American Railroads (AAR) standards are called railroads. While the Pilbara companies are not railway/railroad companies, the iron ore even after it is mined has no value until it is loaded onto a ship. The mining companies are as much transportation companies as mining companies. [8] Woodward, Harry, Page, 'Annual General Report for 1888 -1889', in *Minutes and Proceedings of the Parliament during the First Session of the First Parliament 1890 - 1891,* p. 20.

[9] *Ibid.,* p. 21.

[10] A. Gibb Maitland, *The Iron Deposits of Western Australia: Economic Geology and Mineral Resources of Western Australia,* Minister of Mines, Perth, 1919.

[11] BHP-Utah, 'Koolan: island of ore', Public Affairs, n.d. but probably Perth, 1987.

[12] Michael Edward Causer, 'The 1938 Iron Ore Export Embargo: The Commonwealth Government's motivation & objectives', Master of Commerce thesis, University of New South Wales, December 2000.

[13] *Ibid.*

[14] Fred Affleck, *On Track: The making of Westrail, 1950-1976,* Westrail, Perth, 1978, pp. 87-132; Ronda Jamieson, *Charles Court: I love this place,* St George Books, Osborne Park, WA, 2011, p. 139.

[15] *Ibid*., pp. 141-143.

[16] Submission No. 596 to Cabinet by W.H. Spooner, Minister for National Development, 21 March 1960. The Cabinet approved in principle (Decision No. 722 of 31 March 1960). A5818, vol. 22/Agendum 935, Australian Government National Archives of Australia (NAA); *ibid*. correspondence between Spooner, and Syme, Chairman BHP, Spooner to Syme; *The West Australian,* 3 December 1960.

[17] Note (9) on Appendix A probably written by Spooner, A5818, Vol. 22/Agendum 935 Australian Government, NAA.

[18] Submission No. 919, Iron Ore- Request for Approval to export 500 tons for Metallurgical testing – export policy, A5818, Vol. 22/Agendum 935 Australian Government, NAA.

[19] *The West Australian,* 3 December 1960.

[20] Mike Nahan, *The West Australian,* 29 December 2007, p. 70.

[21] William Stewart Bovell, Minister for Lands, Parliamentary Debates, Legislative Assembly, Western Australia, vol. 161, 16 August 1962, pp. 522-523.

[22] K.D. MacDonald, *Australian Mining and Petroleum Law Journal,* vol. 1, no. 1, 1977, p. 30. [23] G.H. Fewster, 'Financing Mineral Projects', *Australian Mining and Petroleum Law Journal,* vol. 1, no. 1, 1977, pp. 147-8.

[24] *Ibid.,* p. 150.

[25] (Hansard) [WA Assembly], vol. 161, Thursday, 16 August 1962, p. 524.

[26] The Goldsworthy Joint Venturers claimed the invitation was issued on the 11 May. The Mines Department stated it was issued on the 12 May 1961.

[27] Iron Ore (Mount Goldsworthy) Agreement, no. 9 of 1962, p. 56.

[28] Stewart Joy, *The Train that Ran Away: A Business History of British Railways 1948–1968,* Ian Allan, Shepperton, Surrey, 1973, p. 21. Railways have been regulated by Governments from the earliest days; the 'Common Carrier' obligation was a *quid pro quo* for being granted a monopoly. It had to carry any good presented at a reasonable rate; even one totally unsuited to rail traffic, and was detrimental to rail operations. Author's interview with Sir Charles Court, 25 November 2006. During the Second World War he was promoted to the rank of Lieutenant-Colonel and one of his tasks, in preparation for possible invasion, was to move an armoured division by train from New South Wales to Western Australia and back again. He stated that this was a valuable lesson 'about how crazy the (railway) system was.' [29] *Ibid.*

[30] Letter from Mount Goldsworthy Mining Associates to Cooper, CEO, Department of Industrial Development, 1 October 1965, Con. No. 2859, Iron Ore 1959-1967, Item 1965/0119, SROWA. [31] The wagons are self-contained with bottom discharge doors operated by their own air-operated motor. These wagons are heavier and cost more than the ore cars used by the railroads. The ore is discharged into an underground bin.

[32] Co–Co is railway terminology indicating that the locomotive has two x three axle bogies.

[33] Leon Oberg, *Locomotives of Australia: 1850 to 2010,* pp. 336-337, 340-341. The first two locomotives were numbered GML1 and GML2. In 1968 GML1 was almost destroyed in a collision and was rebuilt using a new body and frame from English Electric. When BHP Iron Ore purchased GML in 1991, they were renumbered GML21 and GML22.

[34] Don Lipscombe, '1960-1979', in Peter Firkin (ed.), *A History of Commerce and Industry in Western Australia,* UWA Press, Crawley WA, 1979, p. 141. The ship was named after a president of Cyprus Mines,

[35] Alan Trengove, *Adventure in Iron: Hamersley's First Decade,* Stockwell Press, Clayton, Victoria, 1976, p. 31.

[36] *Ibid.,* p. 25. There are no clear references given but it appears this is a statement from Patrick Robinson of Rio Tinto who made it after a visit to Perth and the Pilbara in December 1959. [37] *Ibid.,* pp. 26-27.
[38] *Ibid.*

[39] James A. Henretta, W. Elliot Brownlee, David Brody and Susan Ware, *America's History,* vol. 2, Worth Publishers, New York, 1993, p. 824.

[40] Trengove, *Adventure in Iron,* p. 44.

[41] 'Iron Ore (Hamersley Range) Agreement, Assented to 13 November 1963',Western Australia Parliamentary Debates, vol. 165, p. 1418, and Act no. 24 of 1963. The term 'or otherwise' means the legal document cannot be altered except by Parliament, or by interpretation of a judge, so as to ensure that it is not misinterpreted. It locks in the meaning, which is that the railway is not a common carrier. [42] Kosmas Tsokhas, *Beyond Dependence: Companies, Labour Processes and Australian Mining,* Oxford University Press, Melbourne, 1986, p. 66.

[43] M.S. Purcell, 'Economics of a Heavy Haul Railway', in *Heavy Haul Railways Conference: Proceedings,* 1978, paper … Session 104, paper A1.

[44] William W. Hay, *Railroad Engineering, vol. 1,* J. Wiley Sons, Inc., New York, 1953, pp. 180-183. [45] James R. Barber and Roger D. Brackett, *Unit Trains,* Kaiser Steel Corporation, Oakland, California, 1972, p. 1.

[46] Trengove, *Adventure in Iron,* p. 87.

[47] John Joyce and Alan Tilley, *Railways in the Pilbara*, J & A Publications, Wembley, WA, 1980, p. 35.

[48] Trengove, *Adventure in Iron*, pp. 87-88.

[49] *Ibid.,* p. 88.

[50] *Ibid.,* pp. 67-70.

[51] H. Samuel, *Railway Operating Practice,* Odhams Press Limited, London, 1962, p. 9.

[52] Trengove, *Adventure in Iron,* pp. 34, 63.

[53] Leon Oberg, *Locomotives of Australia: 1854-2007*, Rosenberg, Kenthurst NSW, 2010, p. 291. Locomotives built in Sydney for the Kowloon Canton Railway between 1955 and 1957 with the 567 diesel engine, developed in 1938, returned to Australia in 2007, rebuilt; they were back in service in 2007.

[54] Alco is used for American Locomotive Company after 1955, and ALCo for the company before 1955.

[55] Albert Churella, 'Corporate culture and marketing in the American railway locomotive industry: American Locomotive and Electro-Motive Respond to dieselization', *Business History Review*, Summer, vol. 69, issue 2, p. 191 (p. 10 in ProQuest copy).

[56] Joyce and Tilley, *Railways in the Pilbara,* p. 53.

[57] Ian K. MacGregor and Rodney Tyler, *The Enemies Within: The Story of the Miners' Strike, 1984-5*, Collins, London, 1986, pp. 41-45.

[58] Ian K. MacGregor, 'Mount Newman – a keystone development', The Institution of Mechanical Engineers, *Proceedings*, vol. 197, no. 80, London, 1983, p. 2.

[59] John McIlwraith, *The First 500 Million: The Mt Newman Story*, Public Affairs Dept., Iron Ore BHP-Utah Minerals International, Perth, WA, 1988, p. 23.

[60] Cable to Charles Court from meeting in New York, GML 119/65, 20 March 1966, SROWA.

[61] MacGregor, 'Mount Newman – a keystone development'.

[62] *Ibid.,* Cost was $200M – Production 100Mt over 22 years. So $200M ÷ 5Mt per year = $40 per annual tonne.

[63] Jamieson, *Charles Court*, pp. 189, 194-195.

[64] Tsokhas, *Beyond Dependence*, p. 98.

[65] *Ibid.*, p. 99.

[66] David Lee, 'The Establishment of Iron Ore Giants: Hamersley Iron and the Mount Newman Company 1961- 1969', *Journal of Australian Mining History*, vol. 11, October 2013, University of Western Australia, Crawley, p. 62. Lee does not fully explain why BHP opposed the lifting of the ban and why they changed their opinion; Letter from C.Y. Syme, BHP to W.H. Spooner, Minister for National Development, 22 April 1960, Series A5818, vol. 22/agendum 935, NAA. There was an element of self-interest, but Syme also points out that BHP were importing 'from New Caledonia about one-Quarter million tons of ironstone per annum', so there did appear to be a shortage of iron ore.

[67] MacGregor, 'Mount Newman – a keystone development', p. 3.

[68] 'Mt. Newman Iron Ore Project: Photographic Progress Report', Bechtel Pacific Corporation Limited, Perth, circa 1969.

[69] *Ibid.;* McIlwraith, *The First 500 million*, p. 27. McIlwraith wrote that CSR had originally a 45 per cent share, increased to 50 per cent, reduced to 30 per cent and then sold 7.14 per cent to AMP. He also claimed that AMAX reduced its shareholding to 25 per cent because a major shareholder and director of AMAX was concerned by the implications of the Vietnam War. The director believed the war would spread across South–East Asia and disrupt trade between Australia and Japan, and argued that AMAX was over exposed with such a major shareholding and convinced the board to reduce its holding. MacGregor, who would know, makes no mention of it.

[70] Colin Drury, *Management and Cost Accounting*, Van Nostrand Reinhold (UK), Wokingham, 1986, p. 530. A profit centre is a separate division where the manager is responsible only for the profits from the assets assigned to him.

[71] *Australians in Company: BHP in its 100th Year*, BHP, Melbourne, 1985, p. 207.

[72] W. 'Bill' Wallwork, 'Mt. Newman Mining Co. Pty. Ltd. – The Early days', Hedland College Bicentennial Programme Presentation, Mount Newman Mining, 1988.

[73] McIlwraith, *The First 500 Million,* p. 35.

[74] Author's interview with Dave Rickards, 2012, described how a large number of Polish labourers were employed on a temporary basis.

[75] MacGregor, 'Mount Newman – a keystone development', p. 7.

[76] McIlwraith, *The First 500 Million,* p. 35.

[77] Patrick Gethin, *The Power Switch at Robe River,* Australian Institute for Public Policy, Perth, 1990, pp. 4-5.

[78] John McIlwraith, *Mesa Harvest: Robe River's First 25 Years,* Robe River Iron Associates, Wickham, 1977, p. 40.

[79] Joyce, Tilley, *Railways in the Pilbara*, p. 79.

[80] Trengove, *Adventure in Iron,* p. 158.

[81] W.P.C. Curlewis, '18 000 Tonne Ore Trains in Australia', *The Railway Engineering Journal*, The Institution of Mechanical Engineers, London, May 1974, pp. 4-17.

[82] *Hamersley Iron Railways Handbook*, Hamersley Iron Pty. Limited, Dampier, 1978, p. 4.

[83] Ray Murphy, Heavy Haul Railways Conference, *Proceedings*, Perth, September 1978, Session 503, paper A.7, p. 1.

[84] Joyce, Tilley, *Railways in the Pilbara,* p. 79.

[85] William S. Autrey, Invitation Keynote Address, *Heavy Haul Railways Conference Proceedings*, Perth, Western Australia, September, 1978.

[86] *Ibid.*, His speech was confusing in that he began describing the cars as 125 ton cars. If they are 125 tons then dividing it by four (axles) will give the axle weight, so a 125 ton car has a 31.25 ton axle load, however, sometimes he seems to refer to a load of 125 tons. To find the axle weight it is necessary to add the tare weight of the car, say 20 to 25 ton and this gives an axle load of 36.25 to 37.5 tons. He also talks about 125 ton loads on four axles and about reducing the load to 100 tons. The important point of his remarks is the actions that the American railroads took to solve their difficulties.

[87] *Ibid.*

[88] V.A. Profillidis, *Railway Engineering,* Avebury Technical, Cambridge, 1995, pp. 36-37. Profillidis confirms that rail studies show that rail fatigue is an exponential function of the axle load.

[89] Steve Marich, William Walker, 'The evolution of railway research and development at a heavy haul railway', *Proceedings of the Institution of Mechanical Engineers,* vol. 207, Section F2 (Journal of Rail and Rapid Transit), London, 1993.

[90] The new rail and wheel profiles were developed from the shape of a rail and wheel that was partly worn. In the old profile, the initial wear was excessive.

[91] Bill O'Neill, 'Mining the heart of a continent', in *New Scientist*, vol. 144, no. 1949, 29 October 1994, p. 54. In an article on mining in Australia, the author stated that on the Mount Newman Railroad, 'Exploiting Australia's remote ore reserves calls for sophisticated technology, complex logistics and hard-nosed commercial drive'.

[92] Brian S. Fisher, Roger Rose, export *infrastructure and access: key issues and progress*, The Australian Bureau of Agriculture and Resources Economics, June 2006, p. 372.

[93] Centre for International Economics, *National Competition Policy Access Regimes and the National Interest: The case study of Pilbara iron ore*, Report prepared for Rio Tinto Ltd., 2006. pp. 14-15. [94] Letter from Robert Williams, Director Travers Morgan to W. Walker, BHP Iron Ore Ltd, advising that their project was a success, 17 May 1994, Collection of W. Walker.